Claims

What is claimed is:

1. An impact generating system for applying rotary percussive impacts to a drill bit, the system comprising:

an anvil for connection to the bit,

a hammer disposed in the anvil for movement about the axis of the anvil in one direction, and

a device for storing energy in response to the movement of the hammer in the one direction and converting the energy into a force in a direction opposite the first direction for driving the hammer in the opposite direction and against a wall of the anvil to produce the percussive impacts.

2. The system of claim 1 further comprising a fluid flow system for directing fluid against the hammer to drive the hammer in the one direction.

3. The system of claim 2 wherein a surface is provided on the hammer against which the fluid impacts for moving the hammer in the one direction.

4. The system of claim 2 further comprising a control device for selectively directing the flow of the fluid against the hammer to cause the hammer to move in the one direction, and for selectively terminating the flow of fluid against the hammer to permit the hammer to move in the opposite direction.

5. The system of claim 4 wherein the control device is a rotating disc in the path of the fluid flow and having at least one slot formed therein, so that the disc selectively directs the flow of the fluid against the hammer and selectively terminates the flow of the fluid against the hammer.

6. The system of claim 2 wherein the hammer is disposed in a chamber that receives the fluid, and wherein the fluid is discharged from the chamber after the flow against the hammer has been terminated.

7. The system of claim 6 further comprising a bypass chamber, and a passage connecting the bypass chamber to the first-mentioned chamber.

8. The system of claim 7 wherein the chambers are formed in the anvil.

9. The system of claim 7 wherein the bypass chamber is defined, at least in part, by a venturi surface that induces the flow of fluid from the first-mentioned chamber to the bypass chamber to permit the hammer to move in the opposite direction.

10. The system of claim 7 further comprising a control device for selectively directing the flow of the fluid into the chamber and against the hammer to cause the hammer to move in the one direction and for selectively terminating the flow of fluid against the hammer to permit the hammer to move in the opposite direction.

11. The system of claim 10 wherein the control device selectively directs the flow of fluid into the bypass chamber when it has terminated the flow of fluid into the first-mentioned chamber.

12. The system of claim 11 wherein the control device is a rotating disc in the path of the fluid flow and having at least two slots formed therein, so that the disc selectively directs the flow into the first-mentioned chamber and into the bypass chamber.

13. The system of claim 12 further comprising a turbine head connected to the disc and adapted to rotate in response to the flow of the fluid.

14. The system of claim 13 wherein the turbine head receives the fluid from a motor.

15. The system of claim 14 wherein the fluid is a drilling fluid that is directed to and through the drill bit to assist the bit in its drilling operation.

16. The system of claim 13 further comprising a housing connected to the motor and receiving the anvil and the turbine head.

17. The system of claim 16 wherein the housing is adapted to rotate with the motor and further comprising a clutch assembly for selectively coupling the anvil to the housing to rotate the anvil with the housing.

18. The system of claim 17 wherein the bit is connected to the anvil so that the bit is rotated when the anvil is coupled to the housing.

19. The system of claim 13 wherein the fluid bypasses the turbine head during the drilling operation and is passed through the turbine head to rotate the disc and impact the hammer when the bit drags or stops rotating as a result of encountering a relatively large load.

20. The system of claim 1 wherein the energy storage device is a spring connected between the hammer and the anvil that compresses in response to the movement of the hammer in the one direction and releases in response to the movement of the hammer in the opposite direction.

21. The system of claim 20 wherein the hammer moves circumferentially relative to the axis of the anvil.

22. A method for applying rotary percussive impacts to a drill bit, the method comprising:

connecting an anvil to the bit;

driving a hammer in one direction in the anvil when the bit encounters a relatively large load;

storing energy during the step of driving; and

releasing the stored energy to drive the hammer in a direction opposite the first direction to produce the percussive impacts.

23. The method of claim 22 wherein the hammer moves circumferentially relative to the axis of the anvil.

24. The method of claim 22 wherein the step of driving comprises discharging fluid against the hammer.

25. The method of claim 24 wherein the fluid is selectively directed against the hammer to cause the hammer to move in the one direction, and further comprising selectively terminating the flow of fluid against the hammer to permit the hammer to move in the opposite direction.

26. The method of claim 25 further comprising locating a disc in the path of the fluid flow and rotating the disc relative to the anvil to selectively direct the flow of the fluid against the hammer and selectively terminate the flow of the fluid against the hammer.

27. The method of claim 24 further comprising providing a chamber in the anvil that receives the hammer and the fluid, and discharging the fluid from the chamber after the flow against the hammer has been terminated to permit the movement of the anvil in the opposite direction.

28. The method of claim 27 further comprising directing the fluid from the chamber to a bypass chamber in the anvil to permit the movement of the anvil in the opposite direction.

29. The method of claim 28 further comprising forming the bypass chamber by a venturi surface that induces the flow of fluid from the first-mentioned chamber to the bypass chamber.

30. The method of claim 29 wherein the fluid is a drilling fluid and further comprising directing the fluid from the chamber to the drill bit for assisting in the drilling operation.

31. The method of claim 29 further comprising locating a disc in the path of the fluid flow and rotating the disc relative to the anvil to selectively direct the flow of the fluid into the first-mentioned chamber and against the hammer and to selectively direct the flow of the fluid into the bypass chamber.

32. The method of claim 31 further comprising forming two slots in the disc so that the disc selectively directs the flow into the first-mentioned chamber and into the bypass chamber.

33. The method of claim 31 further comprising passing the fluid through a turbine head connected to the disc for rotating the head and the disc.

34. The method of claim 31 further comprising directing the fluid so that it bypasses the turbine head during the drilling operation and so that it passes through the turbine head to rotate the disc and impact the hammer when the bit drags or stops rotating as a result of encountering a relatively large load.

35. A method of drilling a well bore through a subsurface formation with a bit connected to the lower end of a drill string, the bit having a bit axis and a bit face extending laterally relative to the bit axis, comprising:

rotating the bit into the formation to form a well bore; and

applying percussive impacts to the bit in a circumferential direction about the bit axis while maintaining a substantially constant axially directed force against the bit.

36. The method of claim 35 further comprising flowing drilling fluid through the bit, converting kinetic energy provided by the flowing drilling fluid into stored energy, and utilizing the stored energy for applying the percussive impacts.

37. The method of claim 36 wherein the step of utilizing comprises releasing the potential energy to a hammer to drive the hammer so that the hammer strikes against an anvil connected to the bit to apply said percussive impacts to the bit.

38. The method of claim 36 further comprising controlling the flow of the drilling fluid through chambers provided in the anvil to repeatedly store and generate the percussive impacts.

39. The method of claim 36 further comprising rotating the drill bit utilizing the flowing fluid.

40. The method of claim 35 further comprising rotating the bit with the drill string.

41. An impact generating system for applying rotary percussive impacts to a drill bit, the system comprising:

an anvil for connection to the bit,

a hammer disposed in the anvil for movement about the axis of the anvil in one direction, and

a fluid flow system for directing fluid against the hammer to drive the hammer in the one direction.

42. The system of claim 41 wherein a surface is provided on the hammer against which the fluid impacts for moving the hammer in the one direction.

43. The system of claim 41 further comprising a control device for selectively directing the flow of the fluid against the hammer to cause the hammer to move in the one direction and for selectively terminating the flow of fluid against the hammer to permit the hammer to move in the opposite direction.

44. The system of claim 43 further comprising a device for storing energy in response to the movement of the hammer in the one direction and converting the energy into a force in a direction opposite the first direction for driving the hammer in the opposite direction and against a wall of the anvil to produce the percussive impacts.

45. The system of claim 43 wherein the control device is a rotating disc in the path of the fluid flow and having at least one slot formed therein, so that the disc selectively directs the flow of the fluid against the hammer and selectively terminates the flow of the fluid against the hammer.

46. The system of claim 41wherein the hammer moves circumferentially relative to the axis of the anvil.